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Title of Paper: High Temperature Stability of Potassium Beta"-Alumina

1. R. M. Williams, M.S. 303-308, Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA, 91109 ph. (818) 354-2727 fax (818) 393-4272
2. A, Kisor, same address
3. M. A. Ryan, same address

Potassium β"-alumina is an ionic conductor which has two potential energy applications, as a precurser ceramic to hydronium and ammonium/hydronium β"-aluminas, and as a solid electrol yte in potassium AMTECs. Two techniques have recentl y been reported for preparation of improved K-β"-alumina. These arc hot pressing of precurser powder at 1300-1500 C, and exchange of K for Na in Na-β"-alumina ceramic, via KCl vapor in air or ox ygcn, at controlled K20 activity at 13001350 C. The stability of potassium β"-alumina solid electrolyte (K-BASE) at high temperatures has been characterized at 925 C in a low pressure potassium atmosphere, and the ceramic shows good stability over a 500 hr test. A potassium-based AMTEC cell was briefly operated with significant power output, and may be predicted to operate with high power and efficiency with heat input near 600 C.

ionic Conductivity of Potassium Beta''-Alumina Ceramic

R. M. Williams, A. Kisor, and M, A. Ryan,

Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA, 91109

The preparation of potassium β"-alumina solid electrolyte (K-BASE) is of interest because of the possible usc of the material in ceramic form in potassium alkali metal thermal-to-electric (K-AMTEC) cells, as well as its exchange with ammonium and hydronium cations to produce ammonium/hydronium β"-aluina, an excellant proton conductor, and hydronium β"-alumina, a good proton conductor at slightly elevated temperatures.

Dense, single-phased K-beta" -alumina ceramics were prepared from Al-oxyhydroxides by hot-pressing at temperatures from 1300-1500 C, at 1300 C producing a single phased beta' '-alumina, and at 1500 C sample consists of a beta/beta' '-alumina, (1) The activation energies of all samples were about 0.4 eV, the ionic conductivities at 300 degrees C, obtained by ac-impedance measurements, bet ween 10(-3)-10(-4) S/cm. (1)

The original preparation of fairly dense K-BASE ceramics by Crosbie and Tennenhouse utilized ion exchange with KCl vapor at 1300- 1400K. [2] We reported the high conductivity of K-BASE ceramics prepared by their method, in potassium atmospheres up to 1200K. [3] We also prepared dense K-BASE ceramics by a modified higher temperature KCl ion exchange technique, at 1575-1625K, using an air or O2 atmosphere and K-BASE powder to maintain the K20 activity; this process gives

gives ceramic with superior mechanical properties and ionic conductivity y. [4] The conductivity y of this material was investigated as a function of time exposed to potassium vapor at low pressure at 1200K; the temperature dependence of the conductivity was also investigated from 800 to 1300K. [5] After an initial small decrease in conductivity, the K-BASE ceramics conductivity is stable or slightly increasing with time at 1200K for 500 hours. The poor conductivity of K-BASE at lower temperatures, compared with Na-BASE, is dominated by high grain boundary resistance, while at higher temperatures, the conductivity is about 1/2 that of Na-BASE, and an abrupt change in apparent activation energy for conduction occurs at about 800K.

The K-BASE ceramic has been utilized to operate a K-AMTEC , and the predicted performance of K-AMTECs exceeds that of Na-AMTECs at lower heat input temperatures, due to the higher vapor pressure of potassium compared with sodium. Predicted AMTEC performance based on measured conductivities of equilibrated K-BASE ceramics will be discussed,

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